# Design and Fabrication of Three Way Trolley Mechanism

Prof. Akshay Pachpore
*Department of mechanical engineering*
*M.I.E.T Shahapur, Bhandara, Maharashtra, India*

Ajinkya Gharote
Department of Mechanical Engineering
*M.I.E.T Shahapur, Bhandara, Maharashtra, India*

Virendra Paulzagade
*Department of Mechanical Engineering*
*M.I.E.T Shahapur, Bhandara, Maharashtra, India*

**Abstract- The older dropping trolley/dumper has been conceived by observing the difficulty in unloading the materials. The survey in this regards in several automobile garages, revealed the facts that mostly some difficult methods were adopted in unloading the materials from the trailer. This paper has mainly focused on above difficulty. Hence a prototype of suitable arrangement has been designed. The vehicles can be unloaded from the trailer in three axes without application of any impact force. The Direction of the mechanism can be control with the help of ball and socket joint which attached the ram of the hydraulic cylinder which lifting the trailer cabin in require side. Further modifications and working limitations will put this work in the main league of use. This concept saves time & energy which leads to efficient working.**

**Keywords - Ball socket joint, Hinge joint, Hydraulic Jack, Pins**

## I. INTRODUCTION

This tipper mechanism can do a great job by unloading the goods in three direction as nowadays trailers unloads in only one direction. Existing trailers requires more space, time and fuel so to overcome these problems we want to introduce the three way tipper mechanism so that the device is economical and efficient.

This tipper mechanism generally relates to ball socket joint for unloading the material in left side or in right side direction and use of hydraulic jack in back side. The ball socket joint is used to provide motion in three direction. In this mechanism, the relative motion of ball socket joint and trolley moves in left and right direction. To unload the material in right side or in left side, we have fix the one side by hinge joint using pin. In this project the hydraulic jack is attached below whole setup to lift the trolley for unloading. This tipper mechanism can be applied to both domestic as well as industrial areas. The proposed mechanism used for unloading purpose is safe and efficient and could be used safely in different areas.

### *1.1FIELD OF USE AND BENEFITS*

This mechanism is useful in dumping vehicles like tractor, trucks etc. This mechanism can provide faster work rate, less human interaction. In existing system, tipper can unload only in one side by using hydraulic jack. That's why in case of two trailer truck, it is difficult for the driver to unload it at only one place and also it consumes more fuel, time, space etc. Wide area is available for research in this topic in order to make it easy for the driver to unload and reduce time and fuel consumption. It is easy to operate, does not required any special skill of driver, rapid, safe operation and simple maintenance.

#### *1.1.1. SINGLE TROLLEY TRAILER*

These type of trailers can unload goods in only back side direction, for this type of unloading either hydraulic or conveyor system is used. Trailers with conveyor system are quite effective than trailers with hydraulic jack but these both systems can unload the goods in only back side direction, therefore more space and time required.

### *1.1.2. TWO TROLLEY TRAILER*

These types of trailers are used to carry more goods at single time to unload two trolleys skilled driver is required also it requires more space, time and thereby fuel requirement increases

## II. PROPOSED MECHANISM

Existing trailers requires more space, time and fuel. So to overcome these problems we have introduced a three way tipper mechanism that would be economical and efficient. This tipper mechanism can do a great job by unloading the goods in three directions. This concept generally relates to hydraulic jack and ball socket joint for unloading material from trailer in left side, right side and back side. A hydraulic jack is a powerful lifting or pushing tool designed to provide effective lift over greater distance than basic mechanical jack. Hydraulic jacks use a plunger mechanism and non-compressible fluid, typically a hydraulic oil, to create required pressure and thus resulting in greater lifting capability.

In this project the hydraulic jack is attached below whole setup to lift the trolley for unloading. This tipper mechanism can be applied to both domestic as well as industrial areas. The proposed mechanism used for unloading purpose is safe and efficient and could be used safely in different areas. This type of system is specially designed for easy unloading of goods in congested space without wasting time and fuel consumption. In traditional tipper, it is capable to lift the load only in one direction i.e. in backward direction. It requires very skilled driver, increases fuel requirement.

In this type of system, hydraulic jack of 2 Tone capacity and ball socket joint plays very vital role. The ball socket joint is able to rotate in 360 degree direction.

The plunger of jack will pump the hydraulic oil at very high pressure. Due to oil pressure the piston start rising in the cylinder. The end portion of the piston is attached to ball socket joint. This end easily rotates in ball socket joint. Socket is provided below the carrier. Hinge pin will be provided at the each corner of the frame and on the chassis also.

If we want to unload the goods on left side then, fixed left side hinge with pin and remove the pins of other two sides and start the raising the hydraulic jack. During this process, the end of the piston which is in contact in the socket start sliding to the left side. Same process is done in case of tilting of trolley to right side by fixing the right side hinges and removing the pins of other two sides to unload the goods. If we want to unload the carrier in backward side, simply remove the pins fixed on right & left hand sides and fixed the hinge with the pin at backside and raise the hydraulic jack. The tipper (carrier) starts raising in backward direction. The hydraulic oil used in hydraulic jack is of grade (GB443-84) N15. It used where ambient temperature is between -2 degree to 50 degree temperature. If oil of other grade is used, then we cannot get rated height. The image of trolley is as follows.

Tipping in left side direction

## III. DESIGN OF TROLLEY

*3.1 Design Of Hydraulic Cylinder*

In this project, hydraulic cylinder plays a very crucial role. Hence design of the hydraulic jack and oil required for jack is necessary. To get the desired height of the jack proper type of oil must be used otherwise it cannot lift the rated load capacity. In this hydraulic jack, oil grade of N15 is used. Following is design procedure of hydraulic jack.

According to AISI CODE, the material used for piston rod is MS SA36 Grade A and its corresponding value permissible stress, б is 407.7 MPa. Then,

б = 407.7 MPa

= 407.7 $N/mm^2$

Let piston diameter = 28mm

Stress = Vertical load on piston / Cross sectional Area of piston

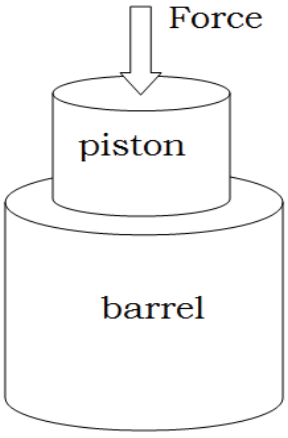


Figure 3.1

$\sigma = F/A$

$F = \sigma \times A$

$= \sigma \times \pi/4 \times D^2$

$= 407.7 \times \pi/4 \times (28)^2$

$= 251165.30$ N

Since, 1 kg = 9.81 N

Therefore,

F = 251165.30/9.81 Kg

F= 25602.98 Kg

And we know that, 1 ton = 1000 Kg

Therefore F= 25602.98/1000 = 25.6 ton.

The value of force calculated above represents the maximum limit of load that can be lifted by the piston rod without failure.

*3.2 Maximum Inside Pressure Of Barrel*

Consider weight of 5 tones acts on the piston. Therefore the pressure created by the piston in cylinder or barrel can be calculated by the following formula

$$Pressure = F/A$$

Where area is the cross section of the piston rod

$$A = \frac{\pi}{4} \times D^2$$

$$= \frac{\pi}{4} \times (28)^2$$

$=615.75$ mm$^2$

We know that

1 tonne = 1000 Kg

Force = 5000 Kg

And,

1 Kg force = 9.81 N

Force = 9.81×5000

Therefore

$$Pressure = F/A$$

$$Pressure = 9.81 \times \frac{5000}{615.75}$$

Pressure P = 79.65 MPa

*3.3 Calculating Thickness Of The Barrel*

First calculating the bore diameter

$F_2 = A_2 \times P \times \beta$

Where β= load rate (β for low speed = 60% to 80%, for high speed = 25% to 35%)

Taking β = 0.3

$49050 = \frac{\pi}{4} \times (D^2-d^2)\times P\times \beta$

$49050 = \frac{\pi}{4} \times (D^2-28^2)\times 79.65\times 0.3$

By solving above equation

D=58.29mm say 59mm

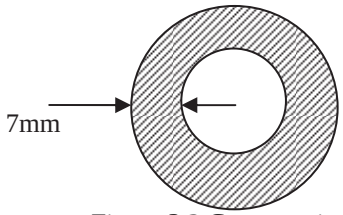


Figure 3.2 Cross section of hydraulic cylinder

Spacing between cylinder bore and piston

$A = \frac{\pi}{4} \times (D^2-d^2) \times t$

$\frac{\pi}{4} \times (59)^2 = \frac{\pi}{4} \times (59^2-28^2) \times t$

t=1.29mm

Therefore inlet diameter of bore = 59+2t

= 59+2×1.29

$D_i$ = 61.58mm say 62mm

Therefore radius $r_i$= 62/2=31mm

For SA36 maximum tensile strength is 410MPa

Using Lame's equation

$\sigma r = b/r^2 - a$

$\sigma c = b/r^2 + a$

For inner radius

$410 = b/(31)^2 + a = \frac{b}{961} + a$

$394.01\times10^3 = b+961a$ …….…… (1)

$\sigma_r = b/r_i^2 - a$

Now $\sigma_r$ = 79.65

$79.65 = b/(31)^2 - a$

$79.65 = \frac{b}{961} - a$

$76.54\times10^3 = b- 961a$ …… (2)

Solving equation (1) and equation (2), we get

b= 235275 N

And a= 165.17 N

Thus Lame's equation becomes

$\sigma r = 235275/r^2 - 165.17$

$\sigma c = 235275/r^2 + 165.17$

Barrel must be strong enough to absorb all stress

Therefore stress at outer surface is zero

бr= 0

Therefore бr = $235275/(r_0)^2$ – 165.17

0 = $235275/(r_0)^2$- 165.17

$R_0$= 37.74 say 38

Therefore outer diameter = $d_0 = r_0 \times 2$

$D_0$= 38×2

Therefore = $d_0$= 76mm

Therefore thickness of barrel

T= $r_0$-$r_i$

T =38-31

T= 7mm

*3.4 Oil required for cylinder*

Stock volume = $\frac{\pi}{4} \times (dia.\ of\ cylinder)^2$×stock length

$V_H = \frac{\pi}{4} \times (62)^2 \times 185$

$V_H$ = 558.528×$10^3$= 558528.04$mm^2$

## IV. CONCLUSION

Till now we were using the trolley with single way dumping mechanism. After literature survey it is found that the traditional method used in trolley consumes a lot of time as well as energy. It also requires trained personnel for activating the mechanism. So these problems present in traditional method could be overcome by proposed mechanism. After few modifications, and working on disadvantages will put this project work in the main league of use. This concept saves time and may lead to efficient working. The constructional work or the infrastructural work demands efficient and user friendly machineries which may lead to more and more use of the present project work.

## REFERENCES

[1] www.shanafelt.com/material-handling-containers.html
[2] Kalaikhathir Achchagam –"Data Book of Engineers" (2007), PSG College of Technology
[3] B.D Shivalkar – Design of machine element
[4] R.K Bansal – Hydraulic Machinaries
[5] S.S Rattan – Theory of machine
[6] Amboji Sudhakar R., Humane Yogesh A., Chavan Rohan R., Patil Jyotsna C., Kshirsagar Prashant R.- Design and Fabrication of Three Way Trolley Mechanism, International Journal of Research in Advent Technology, Vol.2, No.4, April 2014E-ISSN: 2321-9637.-
[7] V. B. Bhandari- "Design Of Machine Element" ISBN-13: 978-0-07-068179-8 (2011) pp.330-331; 544-562.